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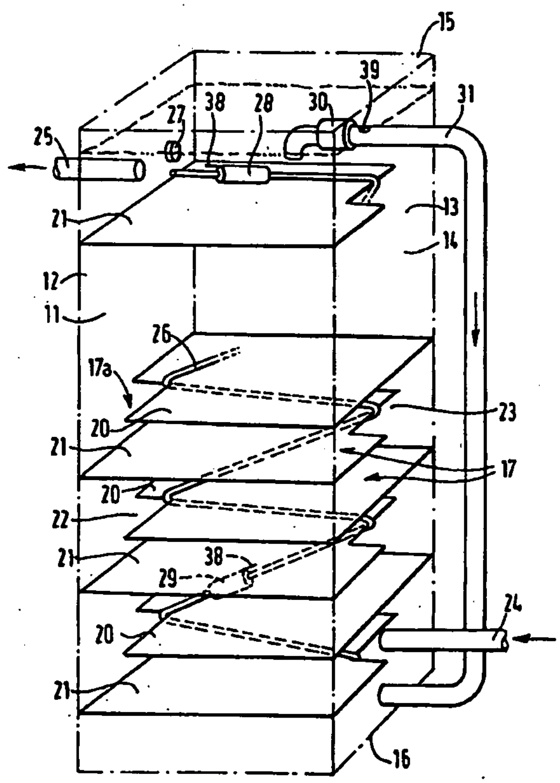
(54) Title: TEMPERATURE CONTROLLED BEVERAGE DISPENSING APPARATUS

(57) Abstract

There is disclosed an apparatus for use in a beverage dispensing machine for controlling the temperature of a potable liquid, the apparatus comprising: a reservoir having an inlet and an outlet, the reservoir being arranged to contain a potable liquid; and means arranged to regulate the temperature of the liquid within the reservoir, when in use, such that the temperature of at least a portion of the liquid becomes stratified.



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TEMPERATURE CONTROLLED BEVERAGE DISPENSING APPARATUS

The present invention relates to an apparatus for controlling the temperature of a liquid within a tank suitable for use in a beverage dispensing apparatus. The invention is particularly, but not exclusively related to a beverage dispensing apparatus for producing at least one of hot and cold drinks.

A conventional apparatus for cooling potable liquids such as drinking water has a coiled pipe through which drinking water is fed, the coiled pipe being immersed in a water bath maintained at an appropriate temperature. However, this apparatus is only able to supply a small number of drinks at the desired cool temperature, equivalent to the volume of drinking water previously cooled by being held within the pipe in the water bath. This usually amounts to only three or four drinks at most. Once these three or four drinks have been dispensed, the user must wait until warmer drinking water supplied to the coiled pipe to replace the dispensed water has cooled sufficiently if further drinks are to be supplied at the desired temperature. This is inconvenient. The water bath is also large and heavy increasing the size and weight of the overall apparatus and cooling the drinking water via a water bath is inefficient since energy is wasted cooling the water in the bath.

A conventional apparatus for heating drinking water involves heating an entire tank of drinking water to maintain it at a desired temperature. This requires either a high energy consumption to heat a large tank of water or the provision of only a small tank which can supply only a small number of drinks on demand.

An object of the present invention is, at least in the preferred embodiment, to provide an alternative beverage dispensing apparatus.

According to one embodiment of the present invention an apparatus for controlling the temperature of a liquid dispensed from a reservoir having an inlet and an outlet comprises means arranged to regulate the temperature of liquid within the reservoir, when in use, such that a temperature gradient is set up in at least a portion of the reservoir.

The provision of a reservoir for cold drinking water, which may be in the form of a tank, enables a large volume of cold water to be accumulated rather than just a volume of drinking water able to be held in structures within a cold water bath as in the conventional apparatus.

The reservoir preferably comprises a series of sequentially interconnected chambers which may be formed by plates and drinking water in the chambers is preferably cooled by a cooling device such as an evaporator. As chilled drinking water is dispensed from one end of the series of chambers, the remaining water in the tank moves through the series of chambers to replace the dispensed water and further ambient temperature water is supplied to the other end of the series of chambers. As drinking water supplied to the tank progresses through the chambers it is cooled each time it contacts the cooling device so that drinking water that has progressed through more chambers is cooler than water that has progressed through fewer chambers. The chambers are preferably arranged in a vertical stack, so that the temperature of water within the tank becomes

layered or stratified with a temperature gradient set up between the inlet and the outlet.

As the drinking water is cooled directly by a cooling device, the water is thus cooled more efficiently than with the conventional apparatus since a water bath of non-drinking water does not need to be cooled, thus reducing energy consumption. Since a water bath is not used the apparatus is smaller, lighter and less expensive to produce than a conventional apparatus.

Ambient temperature water is preferably arranged to be supplied at the lower portion of the tank when in use and cold water is preferably arranged to exit from the upper portion of the tank when in use. The drinking water may be circulated within the tank by a pump to cause the water to pass over the cooling device to enhance its cooling effect. The pump may be situated at any point in the tank and may pump the water either from adjacent the inlet, or vice versa. When the tank is arranged as a vertically stacked series of chambers, the recirclation may cause water to flow from chamber to chamber, either up or down the tank. The preferred recirculation direction is from adjacent the outlet to adjacent the inlet, avoiding reversal of the directions of flow through the chambers.

The cold water tank may be provided with one or more temperature sensors to detect the temperature of the drinking water at particular points within the tank. Alternatively or additionally the cooling device may be provided with one or more ice sensors to detect the level of ice build-up at particular points. The information from at least one of these sensors may be used by a control device such as a microprocessor to control at

least one of the cooling device and the pump. Alternatively or additionally the apparatus may be arranged to indicate the condition of the water in the tank to the user in response to the condition detected by at least one of the sensors.

The provision of stratification of the temperature of water in a hot water tank rather than permitting mixing throughout the tank caused by convection during heating as in a conventional hot water tank enables only a portion of the water in the tank to be maintained at the required temperature rather than having to maintain the entire tank of water at the required temperature. Consequently the energy required to maintain the water temperature is considerably less than that required for a conventional hot water tank whilst still being able to dispense water at the required temperature.

In the hot water tank, ambient temperature water is preferably supplied to the lower portion of the tank and hot water is preferably drawn from substantially the level of the surface of the water in the tank when the tank is in use. The water is preferably heated by a heating element at the lower portion of the tank. The heating element is preferably controlled such that it is able to heat the water so that a temperature gradient is set up in at least the water in the upper portion of the tank so that it becomes layered or stratified. The power of the heating element is preferably selected such that any heating currents set up in the hot water tank during heating do not affect the stratification of the water in at least the upper portion of the tank. The tank may be provided with at least one temperature sensor to detect the temperature of the drinking water at one or more points within the tank. One temperature sensor is

preferably provided at the level at which hot water is drawn from the tank and another is preferably provided at the lower portion of the stratified body of water. The heating element is preferably controlled by a microprocessor. The control of the heating element may be dependent upon the output of or readings from at least one of the temperature sensors and the volume of drinking water drawn from the tank in order to maintain a sufficiently hot body of water ready to be dispensed.

The invention is described further by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram of the water supply system of a beverage dispensing apparatus in accordance with a preferred embodiment of the invention;

Fig. 2 is a partially cutaway perspective view of a cold water tank according to a preferred embodiment of the present invention;

Fig. 3 shows how a pump and a compressor for the cooling system of the cold water tank are controlled;

Figs. 4a and 4b are flow diagrams showing the control of the pump and the compressor;

Figs. 5a and 5b show how the pump and compressor are controlled in more detail;

Fig. 6 is a section through a hot water tank according to a preferred embodiment of the present invention;

Fig. 7 shows how a heater for the hot water tank is controlled;

Figs. 8a and 8b are flow diagrams showing the control of the heating element;

Fig. 9 shows how the heating element is controlled in more detail; and

Fig. 10 shows interconnections between a header tank, cold tank and hot tank according to a preferred embodiment of the present invention.

Figure 1 is a block diagram of an embodiment of the present invention in which water is cooled and heated in appropriate tanks before being carbonated if desired and mixed with an appropriate liquid concentrate whilst being dispensed into a cup to a user.

In Figure 1 a header tank 1 supplies water via supply ducts 1a, 1b respectively to a hot tank 2 in which it is heated and a cold tank 3 in which it is cooled. Since the hot and cold tanks 2, 3 are interconnected by their respective supply ducts from the headertank 1, the water level is the same in both tanks. Hot water dispensed from the hot tank 2 is mixed with a selected liquid concentrate discharged from a discharging device 4 to provide suitable flavouring and colouring such as for soup, hot chocolate, tea or coffee whilst being dispensed in a cup 5. Cooled water dispensed from the cold tank 3 is delivered either to a dispenser for still (non carbonated) drinks, where a concentrate may be added by a discharging device 7, or to a carbonator 6 supplied with a suitable gas where the cooled water is carbonated, preferably as described in European Patent 0166586 or UK Patent 2125309. Carbonated water from carbonator 6 is dispensed into a cup whilst being mixed with a desired liquid concentrate from another discharging device 8.

The discharging devices 4, 7, 8 are preferably as described in European Patent 0478624, and a plurality of discharging devices for hot and cold still drinks and for cold carbonated drinks may be provided.

Figure 2 shows the structure of the cold water tank 3 which has four walls 11, 12, 13 and 14, a top 15 and a bottom 16. The tank contains a baffle structure consisting of a number of vertically spaced horizontal plates 20, 21 which form a number of chambers 17 arranged one above the other which are serially interconnected by cutaway parts 22 and 23 of plates 20, 21 to form a stratified flow path. An inlet 24 is positioned at a lower portion of the tank 3, and an outlet 25 leads from an upper portion of the tank 3. A cooling device 26 is interleaved through the chambers. The plates 22, 23 are arranged in the tank so that the aperture 22 in each plate 20 is diagonally opposite the apertures 23 in adjacent plates 21. The illustrated tank has twelve chambers. As chilled water is dispensed through the outlet 25, the remaining water works its way up the cold water tank, chamber by chamber, passing through the alternate apertures 22,23. Uncooled water is delivered from the header tank 1 into the cold tank 3 through the inlet 24 to keep the tank filled at a desired level above the outlet 25. An evaporator 26 acting as the cooling device is interleaved between the plates 20,21 passing through the apertures 22,23 to cool the water within the tank 3. Although the evaporator 26 is shown having only a single tubular casing it could equally be arranged to have two or more casings. The tank is also provided with a temperature sensor 27 so that the temperature of the water in the chamber adjacent the outlet 25 may be determined. The evaporator is provided with ice detectors 28,29 to detect when ice build-up around the

evaporator casing reaches a particular thickness. Each ice detector has an electrode 38 that is able to conduct electricity through the water to another electrode or to the tank casing acting as an earth. However, when ice builds up around the evaporator and surrounds the electrode 38, the current is cut off because ice is an insulator. This change in output from the electrode 38 is detected. The electrodes 38 of the ice detectors are positioned at set distances from the evaporator casing so that their outputs change when predetermined thicknesses of ice build up around the casing.

The tank has a pump 30 and pipe 31 to circulate drinking water within the tank 3 from the top chamber to the bottom chamber. Circulation of the drinking water within the tank causes the water to flow over the evaporator 26 which enhances its cooling effect. The pipe 31 is provided with a hole 39 within the tank above the water datum level and downstream of the pump 30, so that when the pump is stopped, air enters the hole to stop any syphoning effect. The water could be circulated in the opposite direction and the pump 30 could be positioned at any appropriate point, provided that the anti-syphon hole 39 is positioned above the water level and downstream of the pump.

The temperature sensor 27 and ice detectors 28,29 are monitored using a microprocessor 34 which controls the pump 30 and a compressor (not shown) driving the evaporator 26 as shown in Figure 3.

The operation of the pump and the compressor are controlled by the microprocessor 34 in response to readings from the temperature sensor and the ice detectors as shown in Figures 4a and 4b. In this

embodiment, the pump is turned on when the temperature of the water measured by the temperature sensor 27 exceeds 5.5°C, provided that the tank is full. The pump is turned off when the temperature sensor detects that the temperature of the water at that same point has fallen below 1.5°C.

The ice detector 28 in the top chamber of the tank 3 is set to detect a 5mm thickness layer of ice formed around its corresponding portion of the evaporator casing, and the lower ice detector 29 is set to detect a 3mm layer of ice around its corresponding portion of the evaporator casing. When neither of the ice detectors 28,29 detects its set level of ice build-up around the evaporator casing, ie. when both detectors are conducting, the compressor driving the evaporator 26 is turned on until either ice detector detects its set level of ice build-up, ie. becomes non-conducting.

When the water for one drink is dispensed through the outlet 25 in the uppermost chamber, the same volume of ambient temperature water is released from the header tank 1 to enter a lower chamber of the cold tank 3 through inlet 24 and maintain the volume and water level in the tank. The water in the tank progresses upwards through apertures 22,23 in plates 20,21 layer by layer to maintain the stratified structure of the water temperature. As the uncooled water progresses up the tank it is cooled each time it passes over the evaporator to produce a temperature gradient between the inlet and the outlet with progressively cooler water further up the tank in layers producing the stratification. The volume of each chamber is set to be different from that of a dispensed drink, typically about 1.5 times that of a standard drink (175 ml) so that the water in adjacent

chambers is mixed to provide further cooling as it passes up the tank 3 when a drink is dispensed. Provided that the cooling system of the cold tank has had sufficient time to cool all the water in the tank in advance, the cold tank in the beverage dispensing apparatus is able to supply a number of appropriately chilled drinks equivalent to the volume of the entire tank in rapid succession. The cold water tank 3 typically has about six to sixteen chambers and is able to supply nine to twenty four cold drinks on demand. This enables a low power compressor/evaporator to be used suitable for domestic power supplies whilst still being able to supply a large number of cold drinks on demand. The number and volume of the chambers can however be varied to suit any particular requirements.

Figures 5a and 5b show how the pump 30 and compressor driving the evaporator 26 are controlled. To control the pump 30, the output from the temperature sensor 27, which may be a standard chip able to produce an output voltage dependent upon the surrounding temperature such as an LN35DZ, is applied to an input of each of two comparators 32, 33. The other input of each comparator is connected to a respective one of two reference voltages corresponding to two reference temperatures, which in this case are 15 mV and 55 mV corresponding to 1.5°C and 5.5°C respectively. The outputs from the comparators indicate whether the water temperature in the cold tank is greater than 5.5°C, between 5.5°C and 1.5°C or less than 1.5°C. These outputs from the comparators 32, 33 are processed by the microprocessor 34 to control the pump 30 via a relay in accordance with the flow diagram in Figure 4a.

However, the pump is only actuated if the water level

of the tank is above a minimum level to ensure that the input to the pump is covered by water before operation. A minimum water level indicator 48 shown in Figure 6 may be provided in either the cold or hot tanks, since as they are interconnected both have the same water level. The indicator 48 is connected to the microprocessor 34 via a multiplexer 35 and liquid level chip 36 as shown in Figure 5b. In the present embodiment the minimum water level indicator 48 is provided in the hot water tank at an appropriate level to ensure that the pump inlet of the cold tank 3 is always covered by water.

The multiplexer 35 is provided to enable the microprocessor 34 to select any one of a number of inputs (28, 29, 48, 49) using control lines 37. The multiplexer 35 generally scans the inputs, sampling each one every 70 ms. The liquid level chip conditions the input signals to convert them from a measured resistance into a digital signal indicating, in the case of the minimum water level indicator, either that the water level is at or above the minimum level or it is not. The liquid level chip may be a National Semiconductor LM1830N.

The compressor is also controlled by the system shown in Figure 5b. Each ice detector 28, 29 is sensed by the microprocessor 34 via the multiplexer 35 and liquid level chip 36. If both ice detectors are conducting then the compressor is turned on as shown in Figure 4b until one ice detector becomes non-conducting. The microprocessor will not turn the compressor on for an interval, typically 150 seconds, after it has been turned off because turning it off then on in quick succession is likely to damage it.

Figure 6 shows the structure of the hot water tank 2

which has walls 52, a base 53 and a lid 54. A heating element 41 is provided at a lower portion of the tank 2. An inlet 40 is provided at a lower portion of the tank and an outlet pipe 43 draws liquid from an upper portion of the tank. Unheated drinking water is introduced into the hot water tank through inlet 40 from the header tank 1. The water that is introduced into the hot water tank is heated by element 41. The power of the element 41 is selected such that any mixing of the water produced by the heating of the element 41 does not affect at least the body of water in the upper portion of the chamber in which a temperature gradient is set up in which the water temperature becomes layered or stratified. The temperature of the water at two points in the upper stratified portion of the water in the tank is measured by first sensor T_1 and second sensor T_2. Temperature sensor T_1 is positioned at the lower end of the body of stratified water and temperature sensor T_2 is positioned at the upper end of the body of stratified water. The tank 2 is surrounded by insulation 42 to keep the heat within the tank and prevent it from affecting the chilled water within the apparatus. Hot water is drawn from the tank by an outlet pipe 43 having an inlet 44 close to the surface of the body of water within the tank. The temperature of the water drawn from the tank is measured by temperature sensor T_2. A portion of the body of the outlet pipe passes through the hot water in the tank itself which keeps the water within the outlet pipe hot.

The volume of water which is dispensed from the hot water tank is controlled by a solenoid valve 45. The output water pressure remains constant as the water datum level 52 remains the same as that in the header tank 1 as will be explained later with reference to Figure 10. The size of the hot tank itself and the position and internal

diameter of the outlet pipe 43 also remain constant. Consequently a desired drink volume can be dispensed by controlling the amount of time that the solenoid valve 45 is opened. The outlet solenoid valve 45 opening periods can easily be determined for any particular apparatus to deliver a number of sizes of drinks. A vent 46 is also provided in the top of the hot water tank to maintain the air in the tank above the surface of the water at atmospheric pressure. Otherwise pressure could build up in the top of the tank because of, for example, the release of air dissolved in the water. A steam sensor 47 is provided in the vent to deactivate the heating element if any steam is being produced. If steam is being produced then the water in the tank is being overheated. Furthermore the production of steam is undesirable in a domestic or working environment.

A desired volume of hot drink is selected by an appropriate manipulation of control selectors such as press buttons on the outside of the apparatus. For each particular volume of drink the solenoid valve 45 is opened for a predetermined period of time controlled by a microprocessor.

The heating element 41 is controlled by the microprocessor 34 dependent upon at least one of the temperatures measured by temperature sensors T_1 and T_2 and the period in which the output solenoid valve 45 is open when a drink is dispensed, as shown in Figures 7, 8a and 8b.

Temperature sensor T_2 is set to measure a predetermined set temperature, in this case 93°C and temperature sensor T_1 is set to measure another lower set temperature, in this case, 86.5°C.

The heating element 41 is turned on by the microprocessor when the temperature measured by either temperature sensor T_1 or T_2 falls below its respective set point as shown in Figure 8a or whenever a drink is dispensed as shown in Figure 8b. Whenever a drink is dispensed the heating element is turned on for a period proportional to the amount of water dispensed. In the present case, the element is turned on for a period of five seconds for each second that the solenoid valve 45 is open. This time period for which the heating element 41 is turned on is determined for the particular size of the hot water tank and the power of the heating element, which in this case is 1,250 Watts, so as to maintain the availability of water at the outlet at the desired temperature.

Figure 9 shows how the heating element 41 is controlled. The output of temperature sensor T_1 is compared with a reference voltage of 865 mV corresponding to the set reference temperature of 86.5°C by a comparator 50, and the output of temperature sensor T_2 is compared with a reference voltage of 930 mV corresponding to the set reference temperature of 93°C by a comparator 51. The outputs from the comparators 50, 51 are processed by the microprocessor 34 to control the heating element 41 via a relay in accordance with the flow diagram in Figure 8a.

The period for which the valve 45 is open to dispense a set volume of drink is controlled by the microprocessor 34 in response to a selection by the user. The microprocessor 34 also controls the period that the heater is turned on to compensate for the loss of the dispensed hot water as shown in Figure 8b to pre-heat the water to provide pre-emptive control to be able to maintain a ready supply of suitably hot water.

The microprocessor deactivates the heater or does not turn the heater on if the water level falls below the minimum level detected by liquid level probe 48, to prevent burn-out of the heater.

Figure 10 shows the interconnections between the components of a beverage dispensing apparatus incorporating the present invention. An inverted bottle of water 60 is mounted on a finger 61 of the header tank 1 and whenever the header tank is replenished after supplying water to the hot or cold tank, water passes from the bottle 60, through a hole in the proximity of the top of the finger 61 and through the finger into the header tank 1 as described for example in European Patents 0438451 and 0641713. The datum water level 62 is set by the header tank 1 which, when solenoid valve 63 is opened, maintains the same datum water level 62 in the hot and cold tanks as in the header tank 1. When used with the water bottle 60 and header tank 1 as shown in Figure 10, the solenoid valve 63 need not necessarily be included, in which case the datum water level 62 of the hot and cold tanks 2, 3 will always be maintained at the same level as that of the header tank 1.

The air in the top of the hot water tank 2 is connected to the air in the top of the cold tank 3 by a pipe 64 and the air in the top of the cold tank 3 is vented to the atmosphere via a filter 65. Air in the vented top of the cold tank 3 is also connected to the air in the top of the header tank 1 through a pipe 66 having a non-return valve 67.

Instead of being supplied by a header tank 1 with a bottle of water, the hot and cold tanks could be supplied by the mains water supply connected to solenoid valve 63

as illustrated in Figure 10 by pipe 68 shown by dotted lines. If after water has been dispensed from either tank the minimum liquid level sensor 48 is exposed then the solenoid valve 63 is opened until the water level covers the minimum liquid level sensor 48. The liquid level sensor is sampled every 70 ms by the microprocessor which controls the multiplexer 35 by control lines 37 as shown in Figure 5b to open or close valve 63.

A maximum liquid level sensor 49 could also be provided to ensure that the mains supply is cut off by valve 63 if the water level rises excessively.

Various modifications are possible within the scope of the invention. For example the pump 30, compressor and heating element 41 could be controlled by any arrangement of software and/or electronic hardware and any number of chambers may be provided in the cold tank.

CLAIMS:

1. An apparatus for use in a beverage dispensing machine for controlling the temperature of a potable liquid, the apparatus comprising:

a reservoir having an inlet and an outlet, the reservoir being arranged to contain a potable liquid; and

means arranged to regulate the temperature of the liquid within the reservoir, when in use, such that the temperature of at least a portion of the liquid becomes stratified.

2. An apparatus according to claim 1, wherein the outlet is arranged such that, in use, the liquid to be dispensed is drawn from an upper portion of the reservoir.

3. An apparatus according to claim 1 or claim 2, wherein the inlet is arranged such that, in use, the liquid is supplied to a lower portion of the reservoir.

4. An apparatus according to any one of the preceding claims, wherein the reservoir has means arranged, in use, to cool the liquid.

5. An apparatus according to claim 4, wherein the reservoir comprises a number of interconnected chambers.

6. An apparatus according to claim 5, wherein the chambers are arranged, in use, vertically.

7. An apparatus according to claim 5, wherein the chambers are subdivisions of a single reservoir.

8. An apparatus according to any one of claims 5 to 7, including cooling means arranged to cool liquid within at least some of the chambers.

9. An apparatus according to claim 8, wherein the cooling means is an evaporator.

10. An apparatus according to claim 8 or claim 9, including an ice sensor to detect the level of ice build up on the cooling means.

11. An apparatus according to claim 10, including a first ice sensor arranged to detect a first level of ice build up on the cooling means in the proximity of the inlet to the reservoir and a second ice sensor arranged to detect a second level of ice build up on the cooling means in the proximity of the outlet from the reservoir.

12. An apparatus according to any one of claims 4 to 11, including at least one temperature sensor arranged to detect the temperature of the liquid dispensed from the reservoir.

13. An apparatus according to any one of the preceding claims, including a pump to circulate liquid within the reservoir.

14. An apparatus according to any of claims 10 to 13, including a control means arranged to control at least one of the cooling means and the pump in response to readings from at least one of the temperature sensor(s) and the ice sensor(s).

15. An apparatus according to any one of claims 1 to 3, wherein the reservoir comprises heating means to heat the

liquid.

16. An apparatus according to claim 15, wherein the heating means is a heating element.

17. An apparatus according to claim 15 or claim 16, including at least one temperature sensor.

18. An apparatus according to claim 17, including one temperature sensor positioned at substantially the liquid surface level when the reservoir is in use and another temperature sensor positioned at the lower portion of the body of stratified liquid produced when the reservoir is in use.

19. An apparatus according to any one of claims 15 to 18, when dependent upon claim 2, wherein the outlet is a pipe, one end of which is arranged to draw liquid from substantially the surface of the liquid in the tank when in use and the pipe being arranged to extend at least to a certain extent within the tank to be surrounded by liquid in the tank when in use.

20. An apparatus according to any one of claims 15 to 19, when dependent upon claim 2, including regulating means to control the volume of liquid dispensed by the outlet.

21. An apparatus according to claim 20, wherein the regulating means is a valve.

22. An apparatus according to claim 20 or claim 21, wherein the regulating means is arranged to control the volume of liquid dispensed in a dispensing operation by controlling the duration of the dispensing operation.

23. An apparatus according to any one of claims 16 to 22, including a control means to control the heating element in response to signals from at least one of the temperature sensor(s) and a signal corresponding to the volume of liquid dispensed.

24. An apparatus according to any one of claims 1 to 3, including a cold liquid reservoir according to any one of claims 4 to 14 and a hot liquid reservoir according to any one of claims 15 to 23.

25. An apparatus for dispensing a liquid at a desired temperature from a reservoir comprising:

input means for inputting liquid at a temperature different from the desired temperature into the reservoir;

output means for outputting liquid at the desired temperature from the reservoir;

a plurality of interconnected chambers arranged to form a flow path between the input means and the output means; and

cooling means arranged to cool liquid in at least some of the chambers wherein as liquid progresses through the chambers it is cooled such that a temperature gradient is set up along the flow path with progressively cooler water towards the outlet means.

26. An apparatus for dispensing a liquid at a desired temperature from a reservoir comprising:

input means for inputting liquid at a temperature different from the desired temperature into the reservoir;

output means for outputting liquid at the desired temperature from the reservoir;

means for heating the liquid within the reservoir

and;

means for controlling the heating means such that turbulence does not affect at least an upper portion of the body of liquid within the reservoir such that the temperature of the upper portion of the body of liquid becomes layered or stratified with a temperature gradient such that liquid at the desired temperature is arranged to be adjacent the output means.

27. A method of controlling the temperature of a liquid dispensed from a reservoir comprising regulating the temperature of liquid within the reservoir such that a temperature gradient is set up in at least a portion of the reservoir.

FIG.1

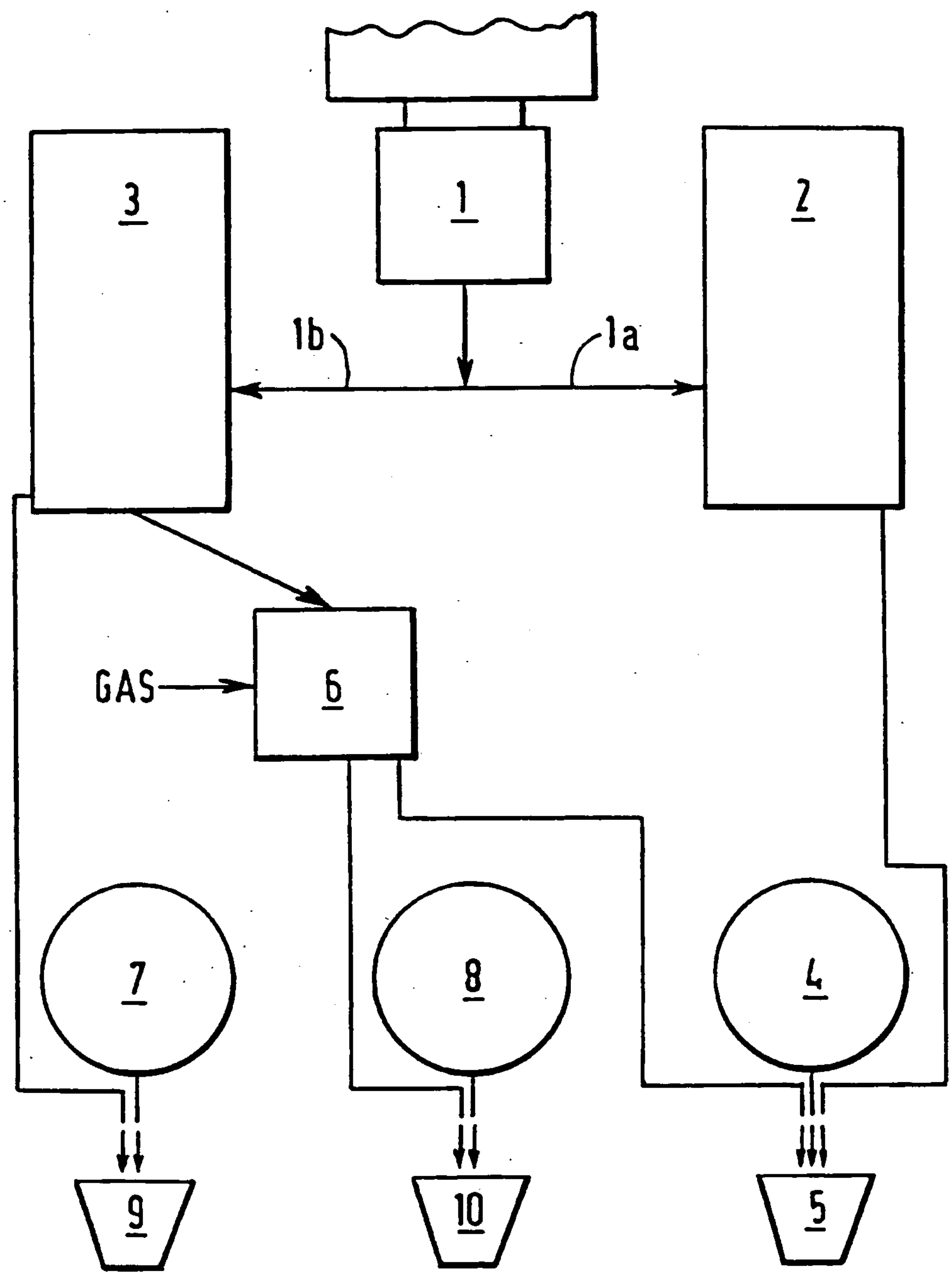


FIG. 2

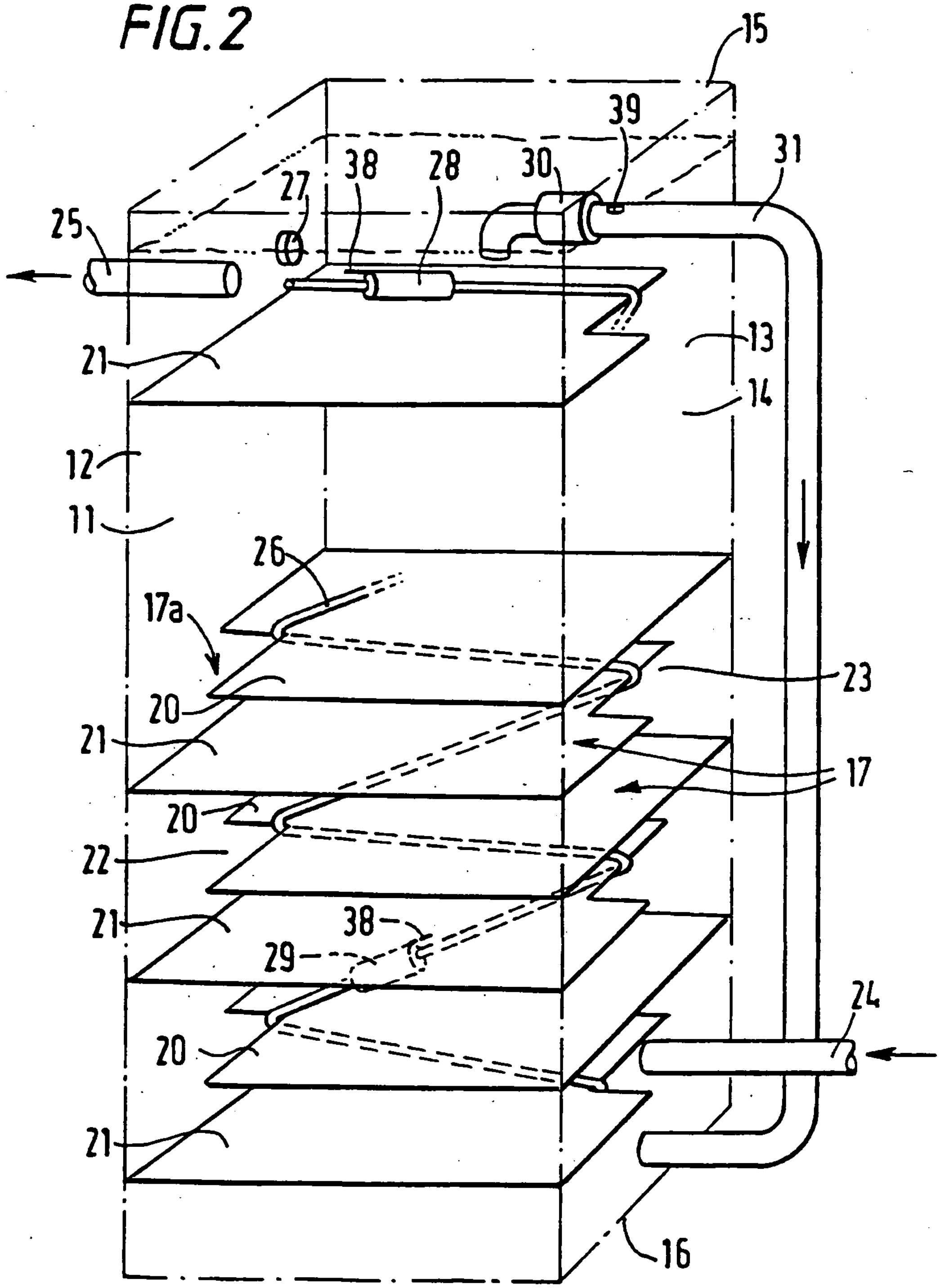

15
39
31
30
28
38
27
25
21
13
14
12
11
26
17a
23
20
21
17
20
22
21
38
29
24
20
21
16

FIG.3

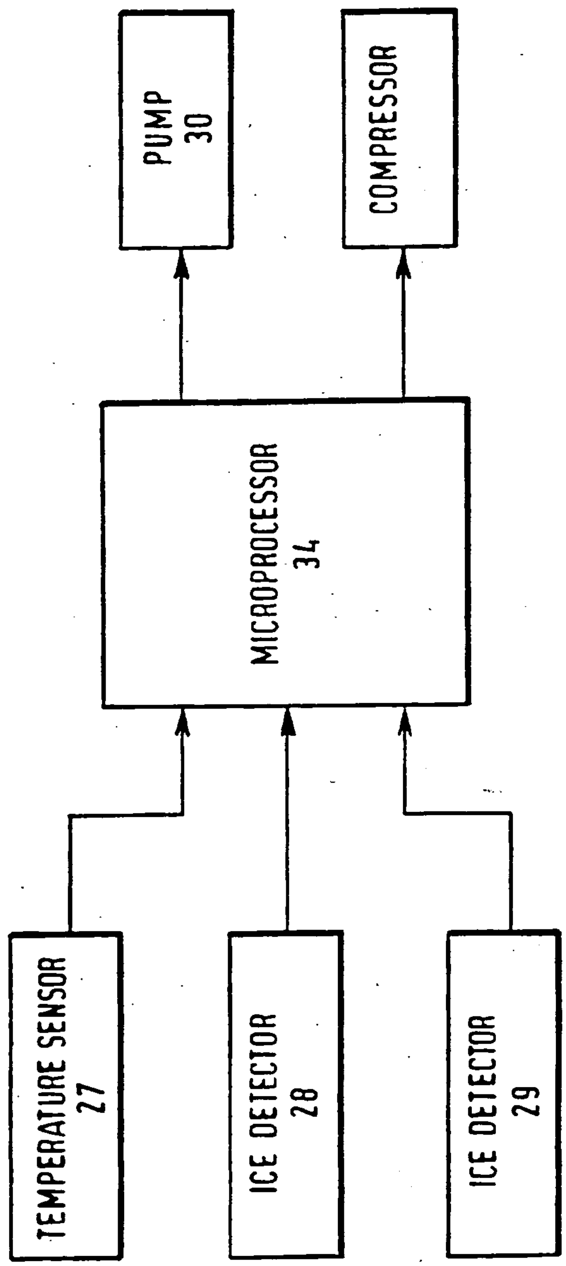

PUMP
30
COMPRESSOR
MICROPROCESSOR
34
TEMPERATURE SENSOR
27
ICE DETECTOR
28
ICE DETECTOR
29

FIG. 4a

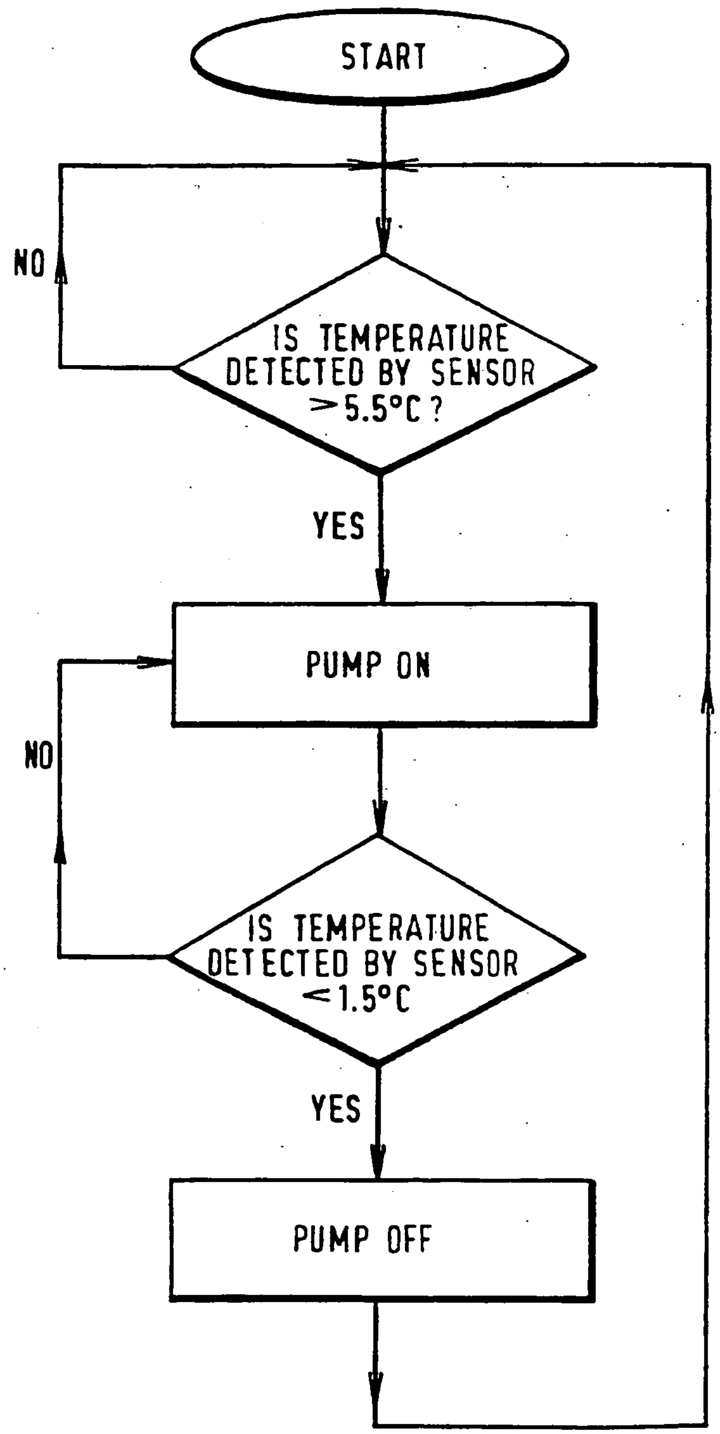
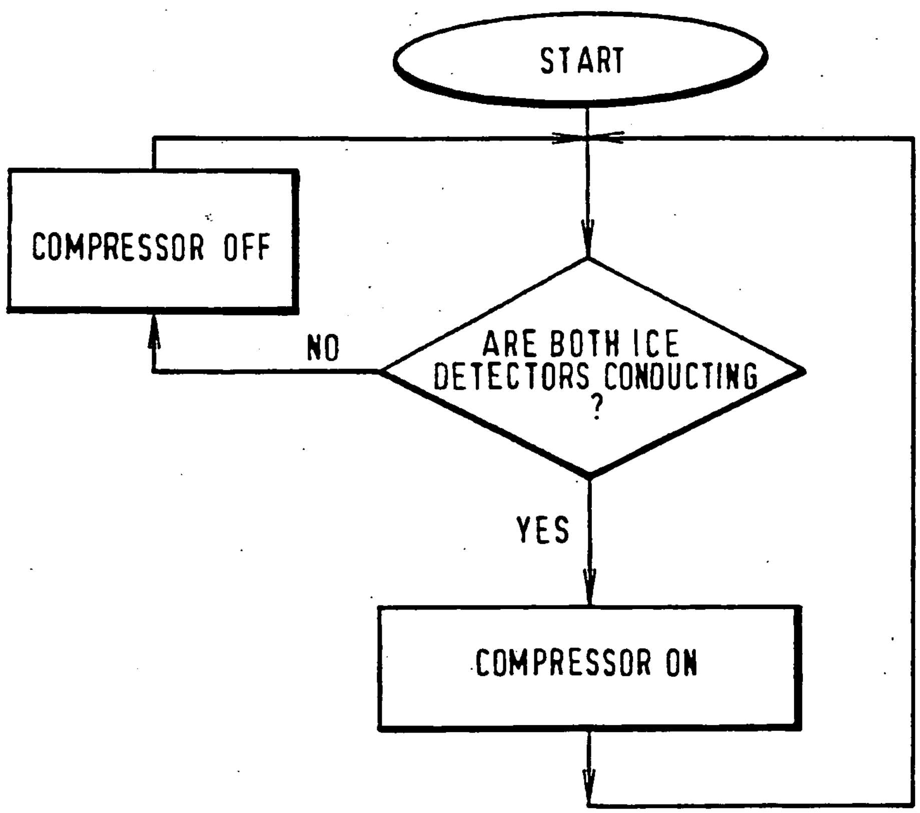

START
NO
IS TEMPERATURE DETECTED BY SENSOR >5.5°C ?
YES
PUMP ON
NO
IS TEMPERATURE DETECTED BY SENSOR <1.5°C
YES
PUMP OFF

FIG. 4b


START
COMPRESSOR OFF
NO
ARE BOTH ICE DETECTORS CONDUCTING ?
YES
COMPRESSOR ON

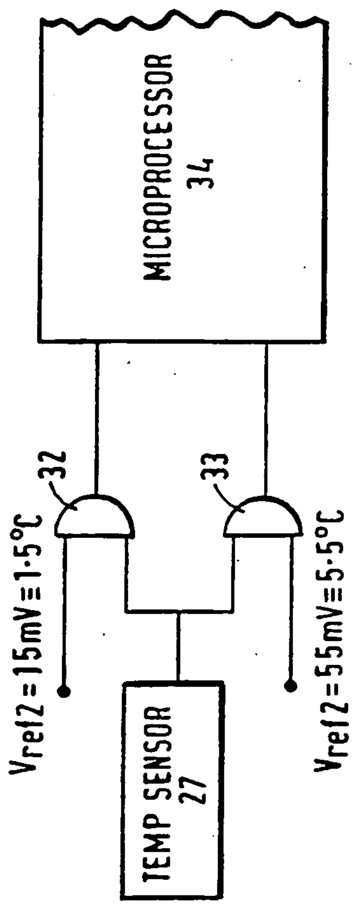

MICROPROCESSOR
34
32
33
Vref2=15mV=1·5°C
Vref2=55mV=5·5°C
TEMP SENSOR
27

FIG.5a

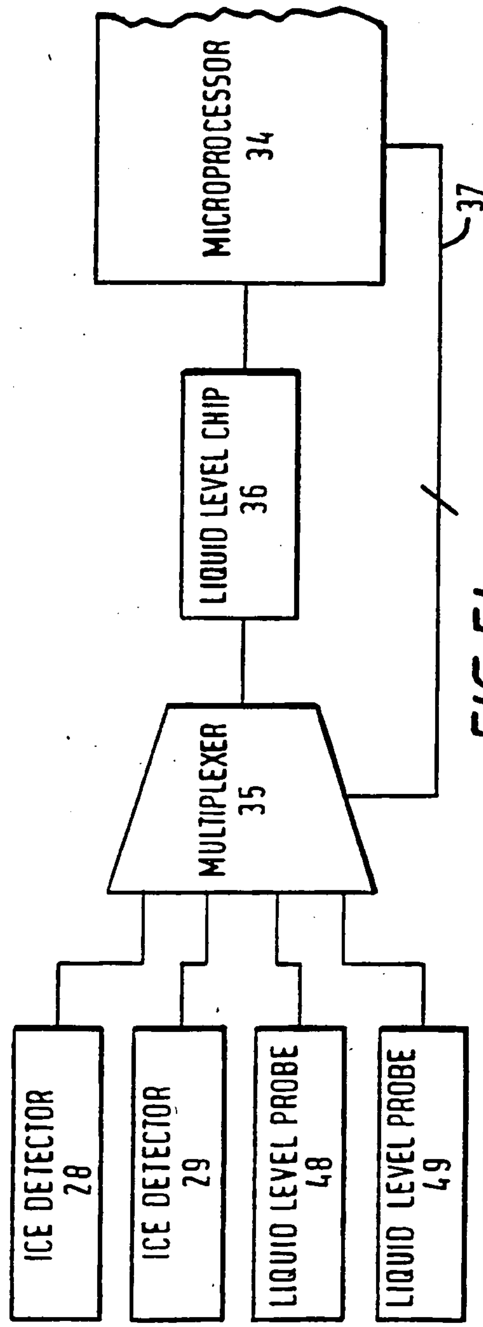

MICROPROCESSOR
34
37
LIQUID LEVEL CHIP
36
MULTIPLEXER
35
ICE DETECTOR
28
ICE DETECTOR
29
LIQUID LEVEL PROBE
48
LIQUID LEVEL PROBE
49

FIG.5b

FIG. 6

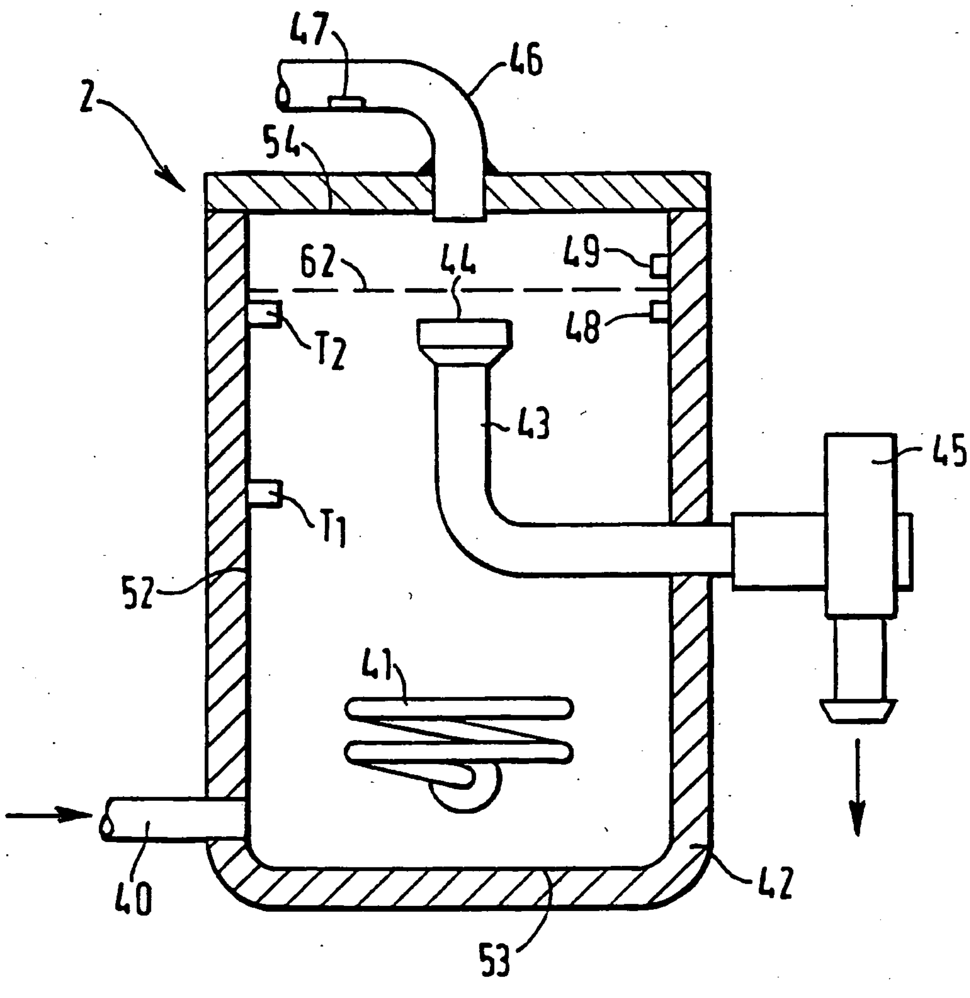


FIG.7

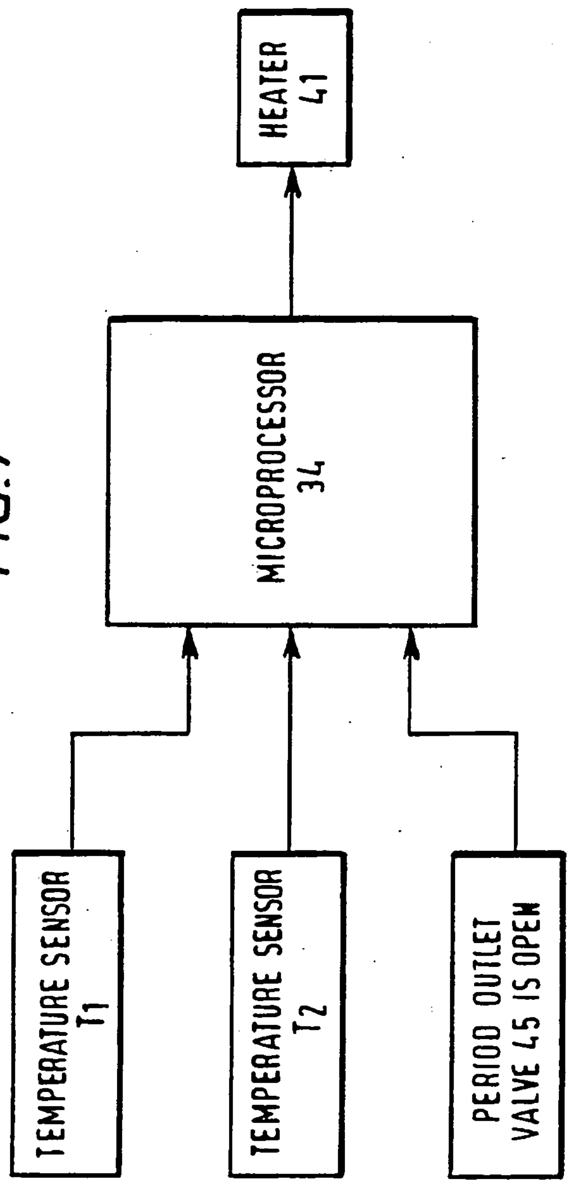

HEATER
41
MICROPROCESSOR
34
TEMPERATURE SENSOR
T1
TEMPERATURE SENSOR
T2
PERIOD OUTLET
VALVE 45 IS OPEN

FIG. 8a

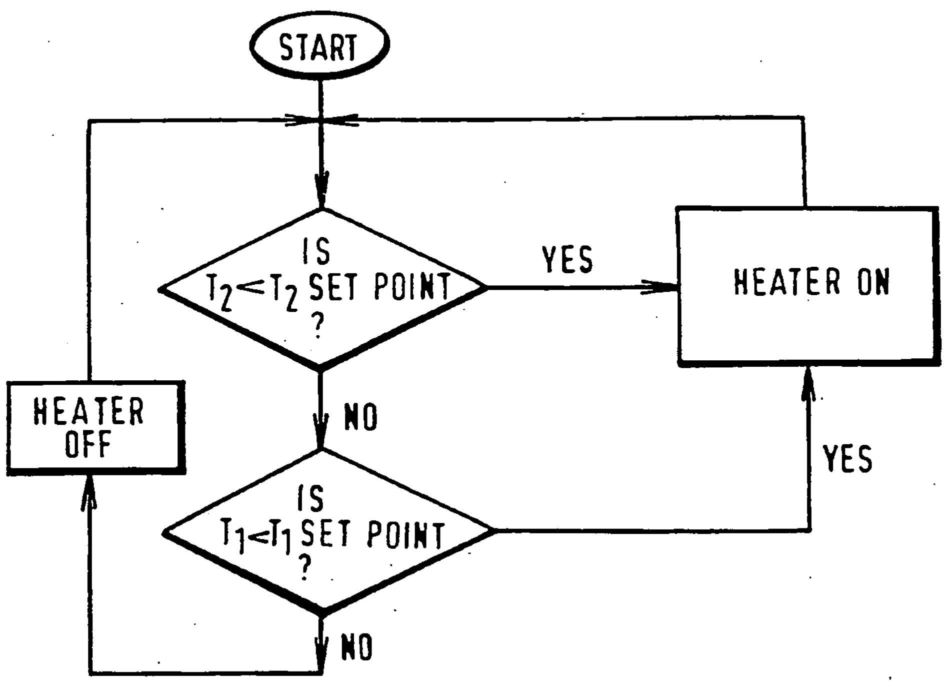
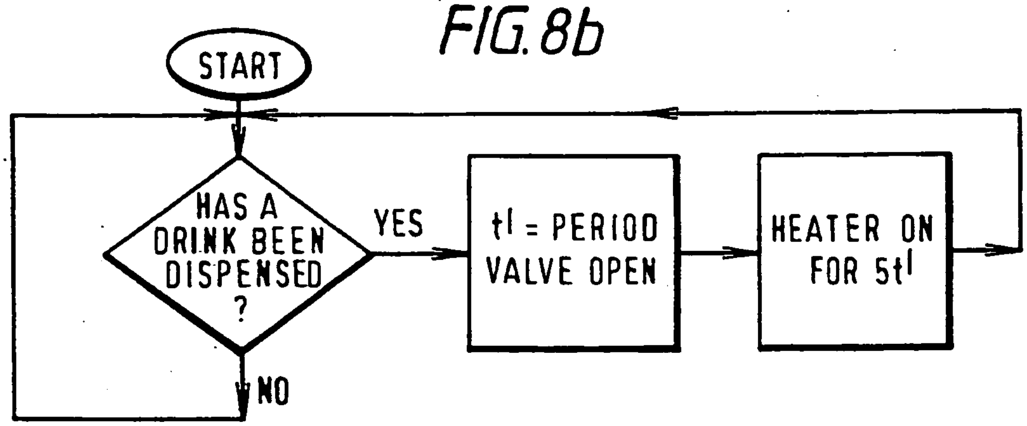


FIG. 8b



T_2 SET POINT = 93°C T_1 SET POINT = 86·5°C

FIG. 9

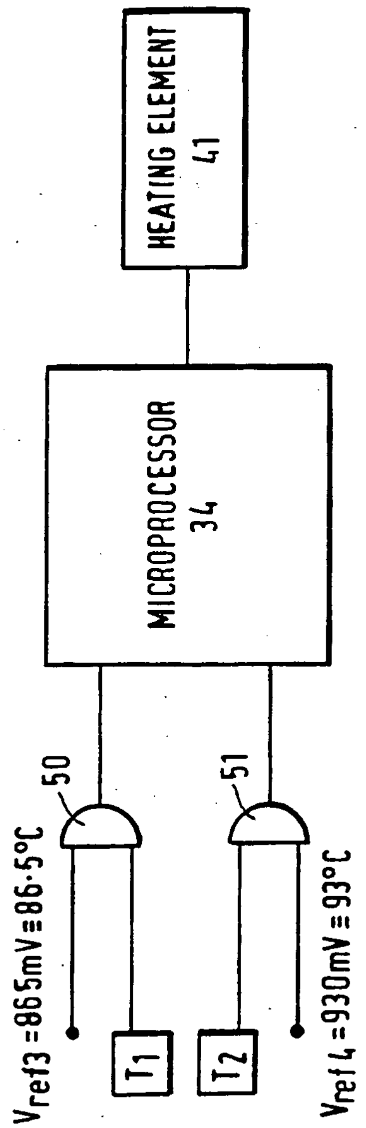
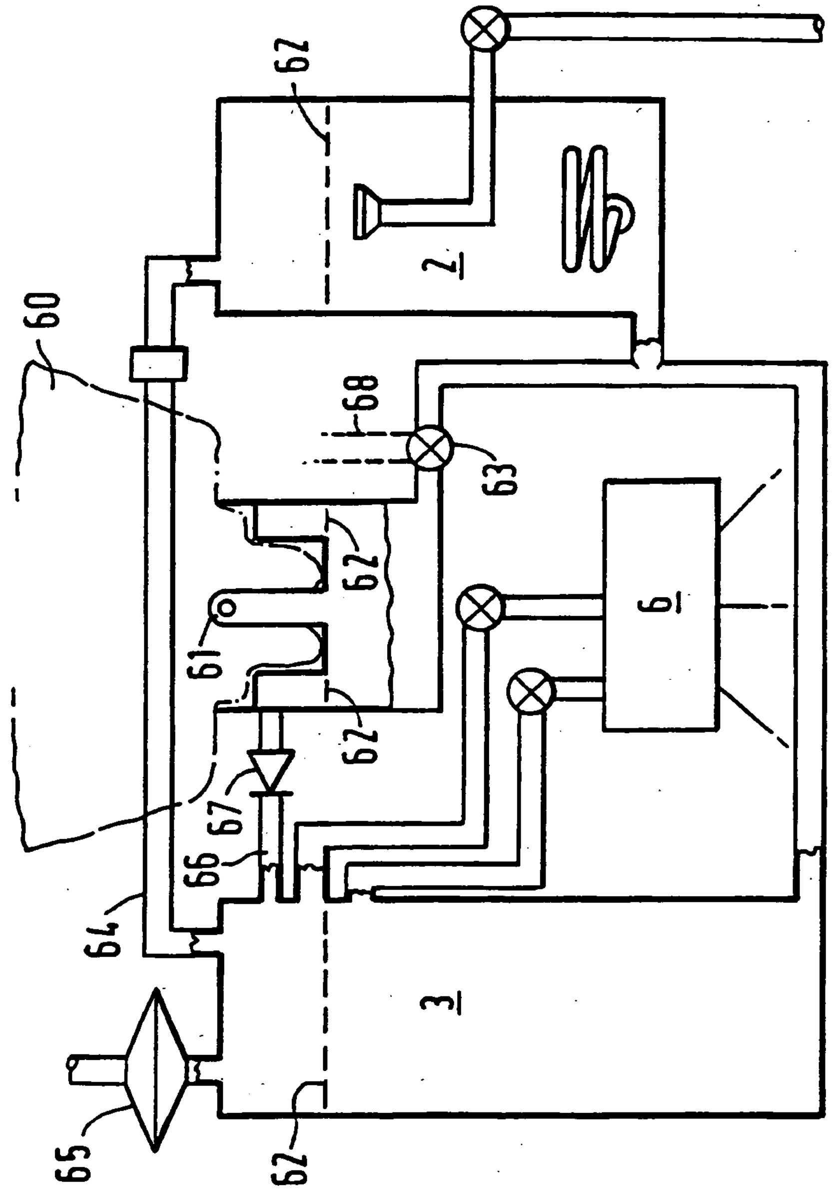

HEATING ELEMENT
41
MICROPROCESSOR
34
50
51
Vref3 = 865mV = 86·5°C
T1
T2
Vref4 = 930mV = 93°C

FIG. 10



INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 98/02052

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B67D3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B67D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 92 18420 A (EBTECH INC.) 29 October 1992 see claims 1,9,10; figures 6,11	1,4-9,25
A		24
X	DE 12 01 710 B (CORY CORP.) 23 September 1965 see column 3, line 20 - column 4, line 5; figures 1,2	1-3, 15-17, 26,27
A	GB 985 841 A (BEDOUET & LARAMY) 10 March 1965 see claim 1; figures 1-3	24
A	US 4 958 747 A (SHEETS) 25 September 1990	

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 October 1998	02/11/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2, NL - 2280 HV Rijswijk, Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Deutsch, J.-P.

1

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 98/02052

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 629 096 A (SCHROER ET AL.) 16 December 1986	

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 98/02052

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